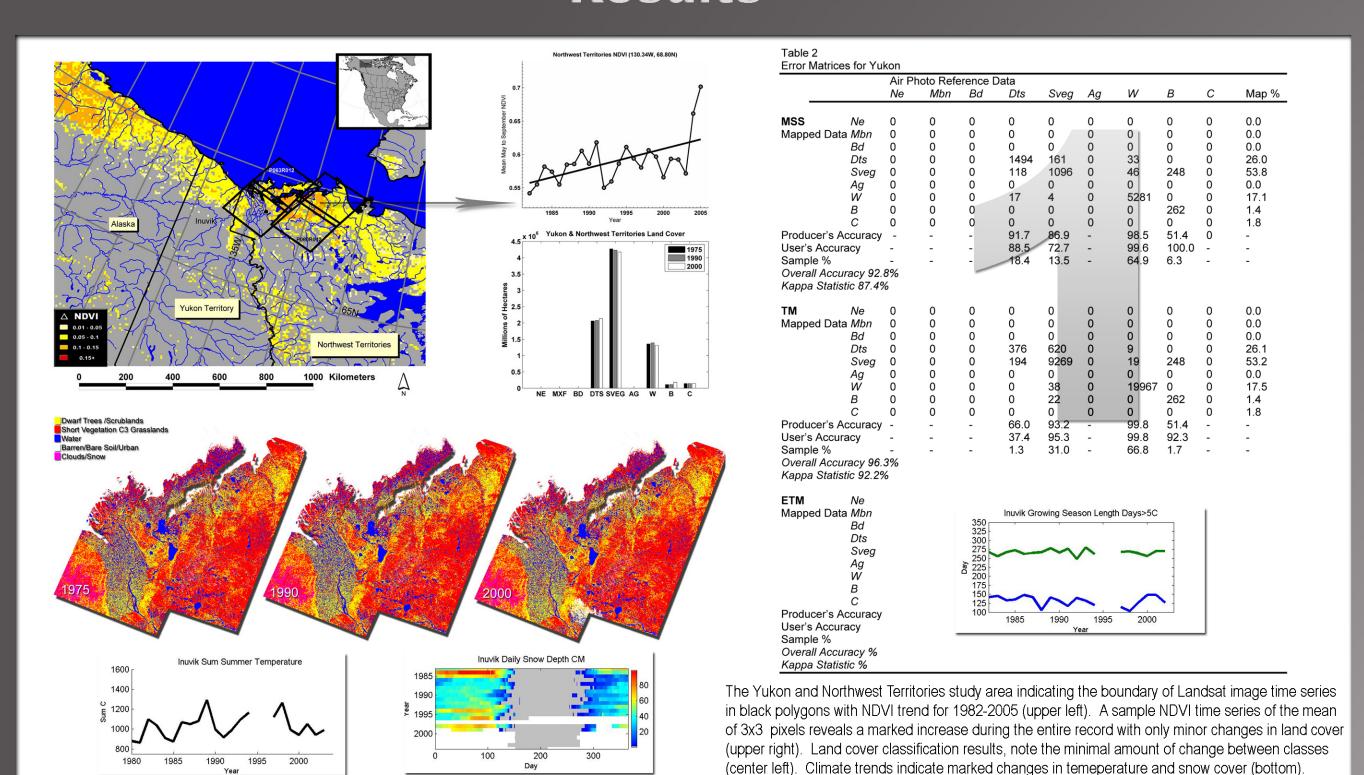


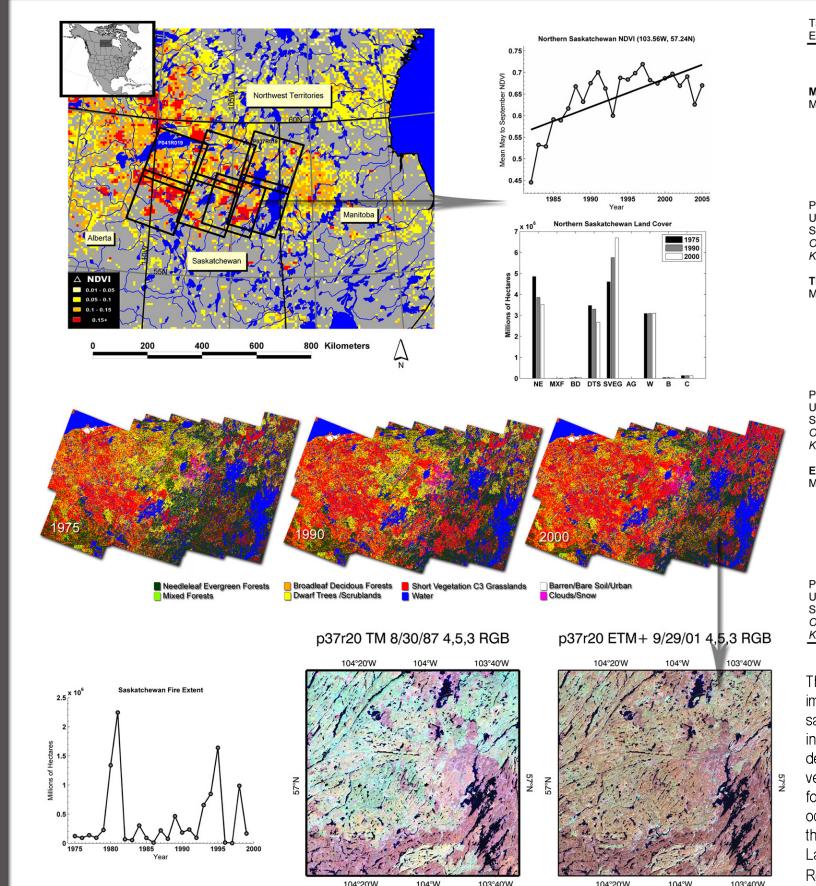
ystem Dynamies Observed with Satellite Date

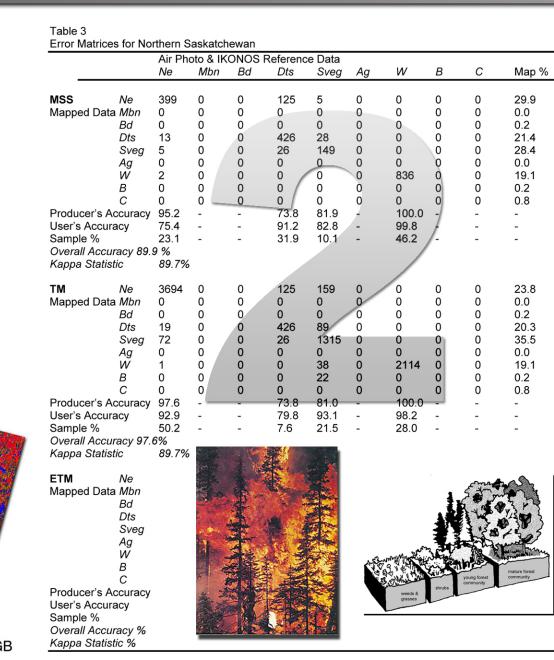


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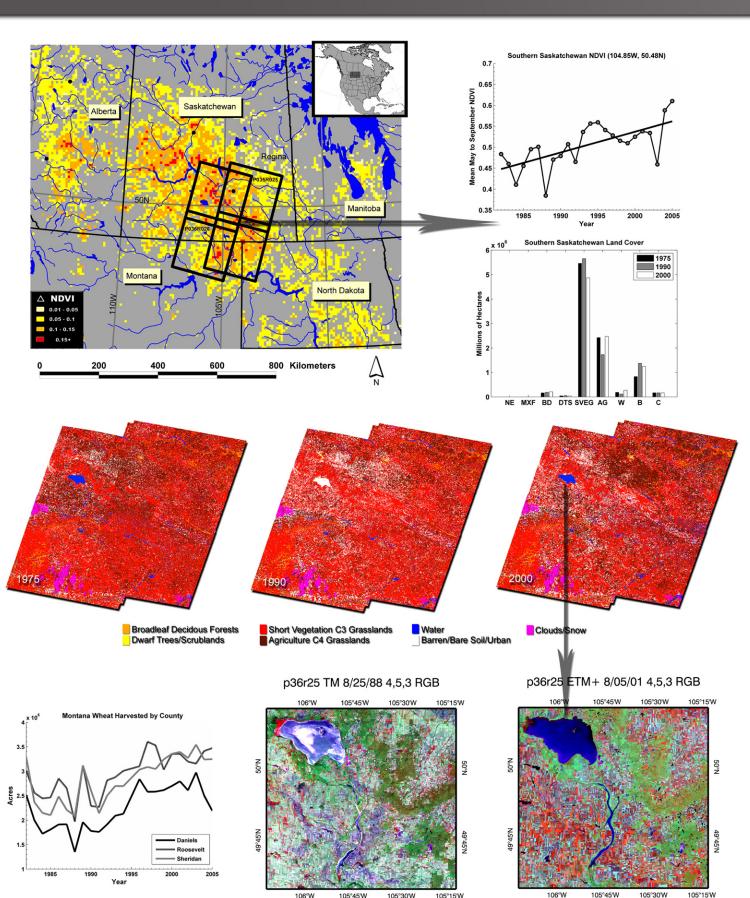
Results

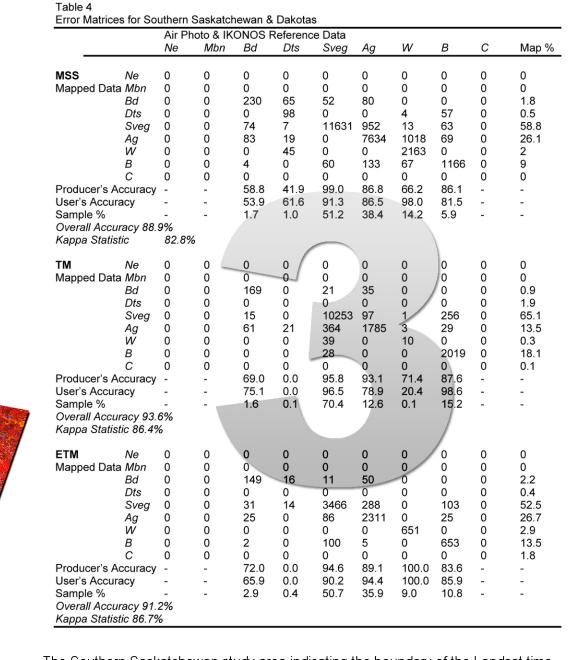






he Northern Saskatchewan study area indicating the boundary of the Landsat image time series in black polygons with NDVI trend 1982-1991 (upper left). A sample NDVI time series reveals an increase during the entire record with a marked ncrease from 1982 to 1991 (upper right). Notice the land cover maps marked decline in needle leaf evergreen and dwarf trees and shrubs being replaced by short vegetation grasslands (center). Extensive fires (>200 hectares) from the Canadian prest service were noted in 1980, 1981, and 1995. The most extensive year occurred in 1981 burning over ~2 million hectares. (lower left). Widespread fires in he early 1980s have induced rapid recovery, an example is provided (lower right) in _andsat. Near infrared reflectance is increasing from green to orange/red in a 4,5,3 Red Green Blue band combination from 1987 to 2001 (lower right).

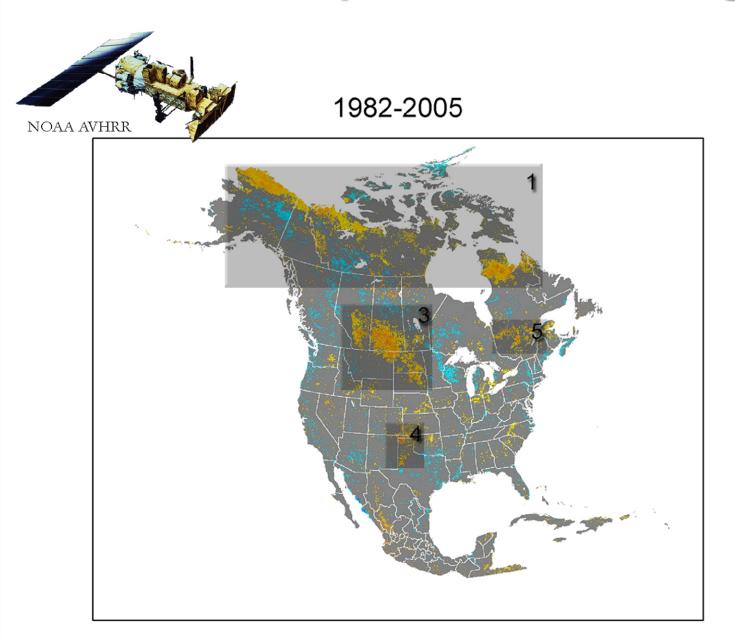


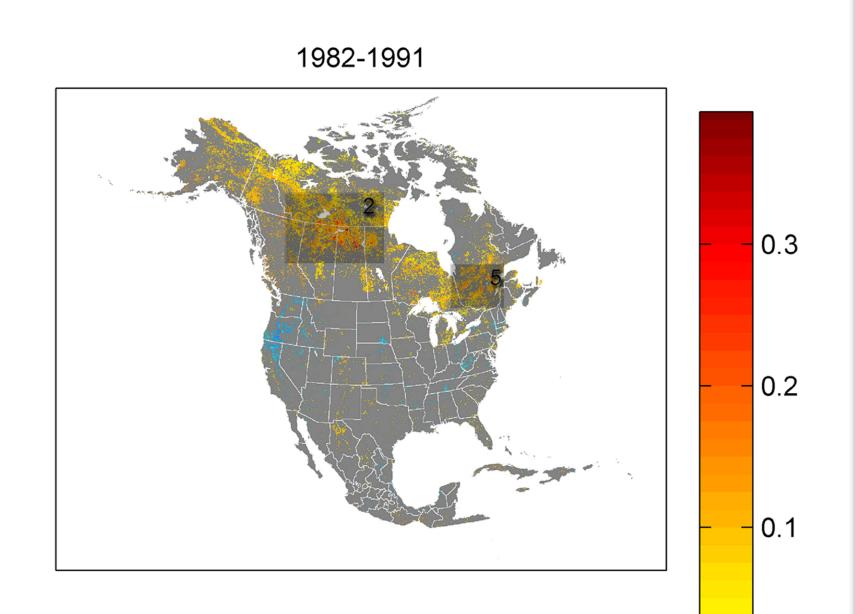


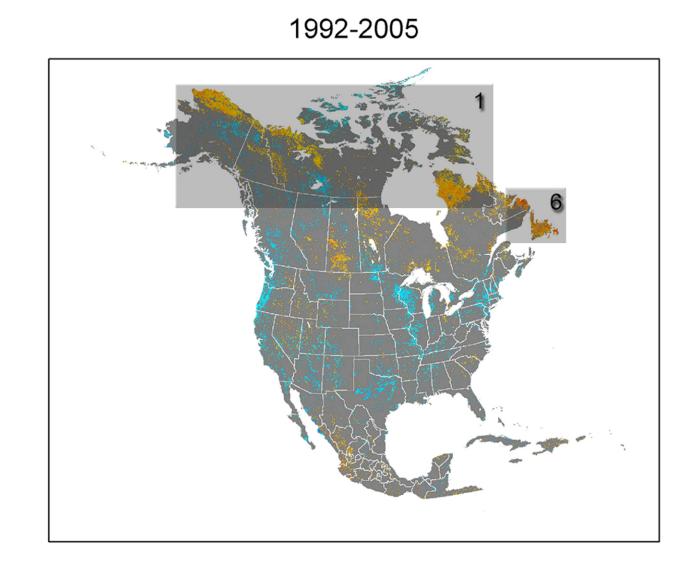
The Southern Saskatchewan study area indicating the boundary of the Landsat time series in black polygons with the NDVI trend from 1982 -2005 (upper left, arrow indicating location of timeseries). Sample of NDVI time series shows marked recover of NDVI after a severe drought in 1988 (upper right). Land cover classification results indicate a decline in agriculture production from drought in 1988 (upper right and middle). Change in productivity of the region was observed as an increase in near-infrared and the midinfrared channels in Landsat imagery (lower right, change from green to red), and a reduction of surface water extent. Notice Old Wives Lake, a large ~20 km2 shallow lake <5m in depth, was primarily barren ground in 1988. Data from the National Agriculture statistics service confirmed a marked increase of wheat yield, the primary crop in this region, from 1982 to 2005, for three counties in northern Montana during the AVHRR

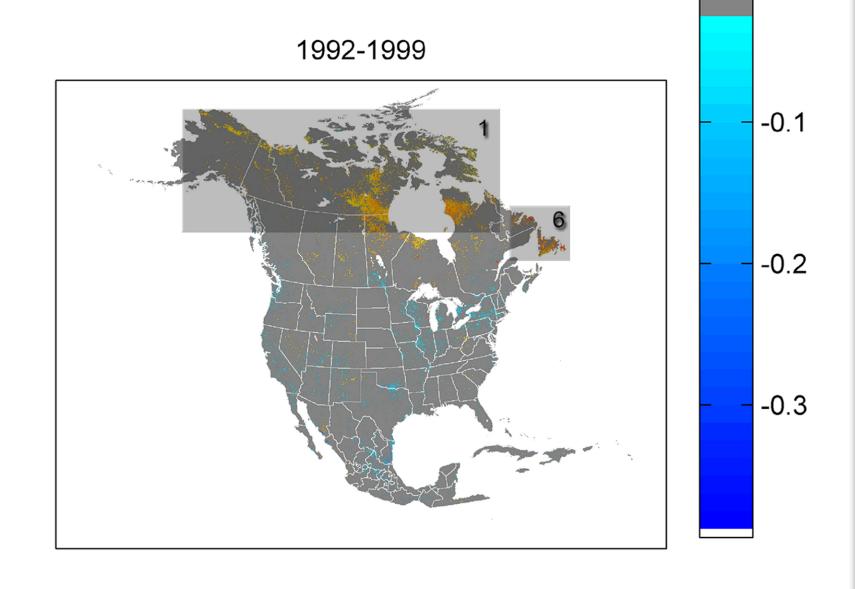
Introduction

Normalized difference vegetation index data from the NOAA series of Advanced Very High Resolution Radiometers (AVHRR) revealed regions in North America that experienced marked increases in annual photosynthetic capacity at various times from 1982 to 2005. Inspection of these anomalous areas with Landsat, Ikonos, aerial photography, and ancillary statistical datasets revealed a range of causes: climatic influences; drought and subsequent recovery; irrigated agriculture expansion; herbivores insect outbreaks followed by logging and subsequent regeneration; and forest fires with subsequent regeneration. We describe an efficient continental monitoring system that can identify major land use/land cover changes and climatic influences upon North America vegetation.







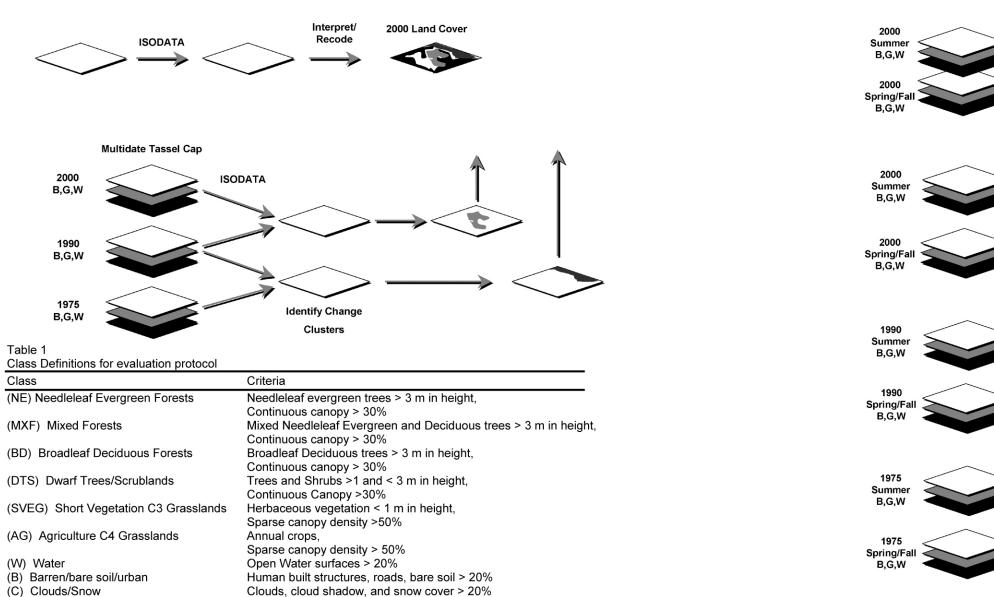


Mask Change on 2000 Classification

Identify Change

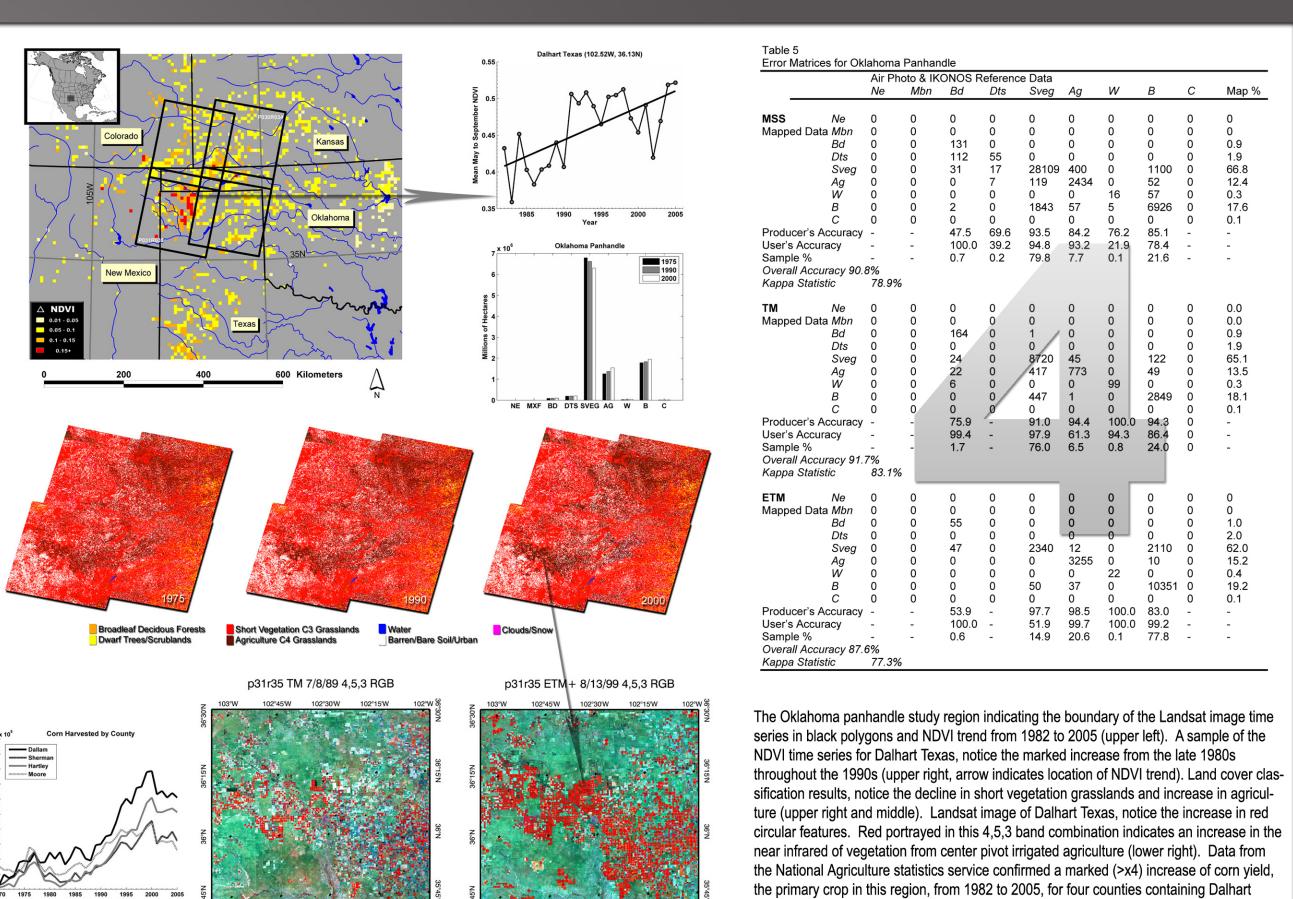
Methods

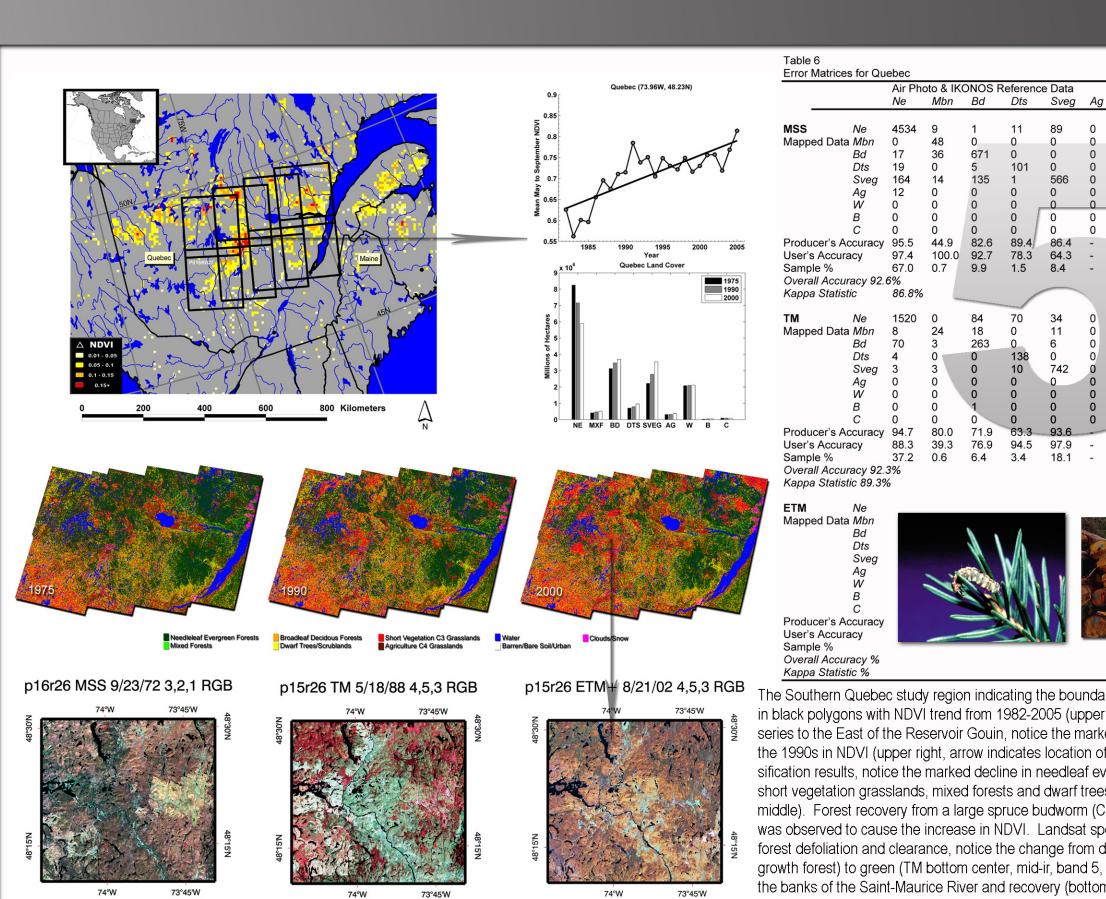
Growing season May to September annual AVHRR NDVI trends. Study regions selected if linear increases are greater than 0.1 NDVI units over the period of 1982 to 2005, 1982-1991 and 1992 to 2005. Note that trends previously reported in Slayback et al. 2003 and Tucker et al. 2001 ended in 1999, we have extended this record through 2005. We select six contiguous regions based on two assumptions: (a) A contiguous region has an NDVI trend greater than >0.1 from selected observational periods and, (b) High resolution remote sensing data and corresponding validation data are available for intensive analysis for the entire AVHRR record. Six regions meet these criteria include: (1) the Mackenzie River delta, (2) Northern Saskatchewan, (3) Southern Saskatchewan, the (4) Oklahoma panhandle, (5) Southern Quebec, and (6) Newfoundland

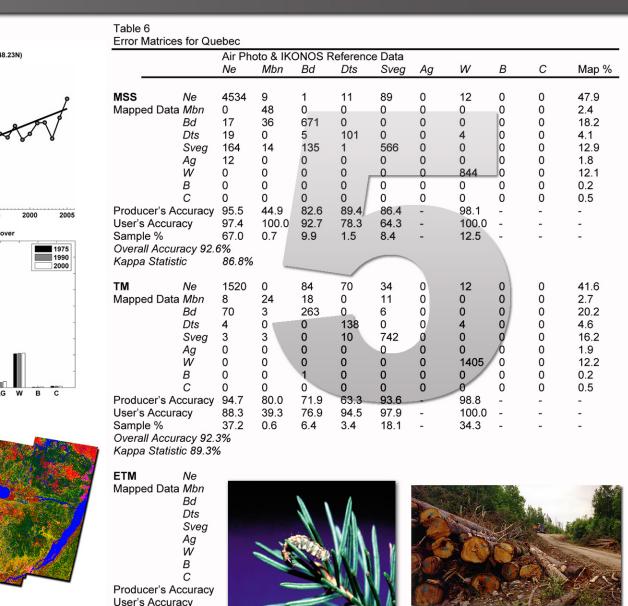


(Upper Left) Land cover classification method developed for boreal regions of North America to extract thematic information from multispectral Landsat data. Channels 3,4 and 5 are used from the Landsat Enhanced Thematic Mapper data to first develop a thematic map of International Geosphere Biosphere Program classification cover types. The processing procedure then reverts in time to the Landsat Thematic Mapper and Multispectral scanner data for predate cover types of mean dates 1990 and 1975. Only regions of change are modified in the original 2000 data for predate 1990 and 1975 thematic maps to minimize the compounding of classification errors that can occur with variance between instruments. (Upper Right) Land cover change classification algorithm diagramming processing steps to extract thematic data from Landsat for Midwest agriculture regions. Method two was adapted for regions with irrigated agriculture to capture inter annual variability in crop productivity. Performing a transformation on multidate tassel cap images captures active irrigated agriculture and distinguishes between fallow agriculture and native grasslands.

Results

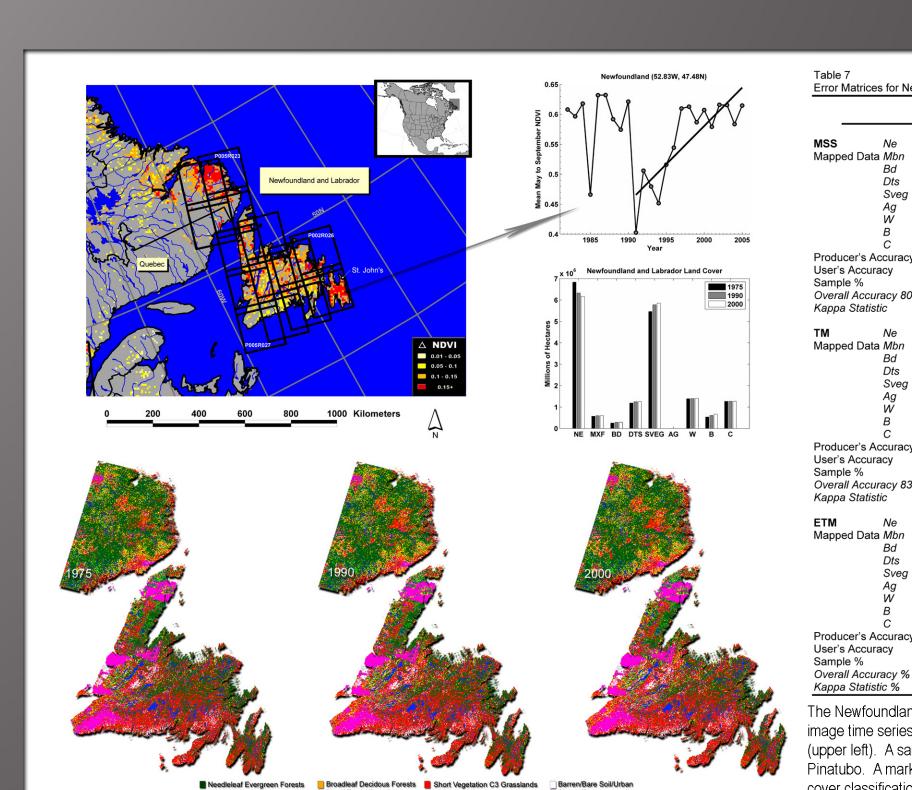


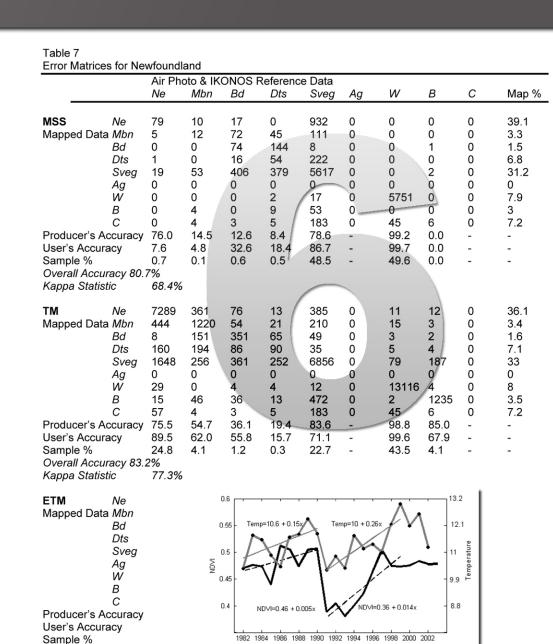




Texas during the AVHRR record (lower left).

The Southern Quebec study region indicating the boundary of the Landsat image time series in black polygons with NDVI trend from 1982-2005 (upper left). A sample of the NDVI time series to the East of the Reservoir Gouin, notice the marked increase from early 1980s into the 1990s in NDVI (upper right, arrow indicates location of the NDVI trend). Land cover classification results, notice the marked decline in needleaf evergreen forests and increase in short vegetation grasslands, mixed forests and dwarf trees and shrubs (upper right and middle). Forest recovery from a large spruce budworm (Choristoneura fumiferana) outbreak was observed to cause the increase in NDVI. Landsat spectral reflectance increased after forest defoliation and clearance, notice the change from dark red (MSS bottom left, old growth forest) to green (TM bottom center, mid-ir, band 5, short vegetation grasslands) along the banks of the Saint-Maurice River and recovery (bottom right) as increase in orange (ETM+, band 4, near-ir, regrowth of forests, arrow indicates the location of the image enhancement) in a 4,5,3 band combination.





The Newfoundland and Labrador coast study region. The boundary of the Landsat (upper left). A sample NDVI time series reveals an increase after the volcanic eruption of Pinatubo. A marked increase in NDVI from 1992 to 2005 occurred (upper right). Land cover classification results, notice the decline of needle leaf evergreen forest being replaced by short vegetation grasslands and barren lands (center & bottom left). Changes in land cover from the 1990 to 2000 maps do not support the marked change in NDVI. Temperature is synchronous with NDVI in this region (lower right).